Issued by the Colonial Office

EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

TENTH ANNUAL REPORT

1st April, 1937—31st December, 1937

Crown Copyright Reserved

IMPERIAL MYCOLOGICAL INSTITUTE
28 MAR 1939

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
York House, Kingsway, London, W.C.2; 120 George Street, Edinburgh 2;
26 York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff;
80 Chichester Street, Belfast;
or through any bookseller
1938
Price 1s. 0d. net
Colonial No. 151

Reports, etc., of Imperial and Colonial Interest

THE SYSTEM OF APPOINTMENT IN THE COLONIAL OFFICE AND THE COLONIAL SERVICES

Report of a Committee on [Cmd. 3554 (1930)] 1s. (1s. 1d.)

LEAVE AND PASSAGE CONDITIONS FOR THE COLONIAL SERVICE

Report of Committee on [Cmd. 4730 (1934)] 9d. (10d.)

ECONOMIC SURVEY OF THE COLONIAL EMPIRE

A comprehensive Survey, including Memoranda on the Economic Situation of the individual Dependencies and on the Products of the Colonial Empire

Survey for 1935 [Colonial No. 126] £1 5s. (£1 5s. 8d.)

EMPIRE SURVEY

Report of the Proceedings of the Conference of Empire Survey Officers, 1935

The Conference was mainly occupied with questions related to trignonometrical and topographical surveying. It also discussed the various aspects of air survey work with particular reference to aerial photography and the production of charts and maps [Colonial No. III) £1 (£1 os. 6d.)

VOCATIONAL AGRICULTURAL EDUCATION IN THE COLONIAL EMPIRE

A Survey [Colonial No. 124] 6d. (7d.)

COLONIAL DEVELOPMENT

Report of the Colonial Development Advisory Committee for the period 1st April, 1936, to 31st March, 1937 [Cmd. 5537] 6d. (7d.)

PALESTINE

REPORT of Royal Commission [Cmd. 5479] 6s. 6d. (6s. 8d.)

Minutes of Evidence (with Index) [Colonial No. 134] £1 15s. (£1 15s. 6d.)

Memoranda prepared by the Government of Palestine [Colonial No. 133] 9s. (9s. 6d.)

Summary of Report (with Extracts and Map) (Colonial No. 135] 9d. (10d.)

STATEMENT OF POLICY by His Majesty's Government in the United Kingdom [Cmd. 5513] 1d. (1½d.)

EDUCATION OF AFRICAN COMMUNITIES

Memorandum by the Advisory Committee on Education in the Colonies [Colonial No. 103] 6d. (7d.)

HIGHER EDUCATION IN EAST AFRICA

Report of the Commission appointed by the Secretary of State for the Colonies [Colonial No. 142] 2s. 6d. (2s. 8d.)

BROADCASTING SERVICES IN THE COLONIES

Interim Report of a Committee [Colonial No. 139] 6d. (7d.)

All prices are net. Those in brackets include postage

Obtainable from

HIS MAJESTY'S STATIONERY OFFICE

LONDON, W.C.2 : York House, Kingsway
EDINBURGH 2 : 120, George Street MANCHESTER 1 : 26, York Street
CARDIFF : 1, St. Andrew's Crescent BELFAST : 80, Chichester Street
or through any bookseller

Continued on page 3 of cover

Issued by the Colonial Office

EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

TENTH ANNUAL REPORT

1st April, 1937—31st December, 1937

Crown Copyright Reserved

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
York House, Kingsway, London, W.C.2; 120 George Street, Edinburgh 2;
26 York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff;
80 Chichester Street, Belfast;
or through any bookseller
1938
Price 1*s.* 0*d.* net

Colonial No. 151

TABLE OF CONTENTS

	Page.
Staff	3
Report of the Director	4
Research	4
Administration	6
Plant Pathology	9
Entomology	14
Soil Science	14
Biochemistry	18
Plant Physiology	19
Sisal	21
Plant Genetics	23
Systematic Botany	29
Ornithology	30
Plantation Work	32
Amani	32
Kwamkoro	34
Visitors	36
Appendix A.—Financial Statement for the Year ended 31st December, 1937.	37
Appendix B.—Publications	38

EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

Report for the Period 1st April, 1937, to 31st December, 1937

STAFF LIST.

Director.—A. G. G. Hill, B.A., B. Agr., A.R.C. Sc. I.

Plant Pathologist.—H. H. Storey, M.A., Ph.D.

Entomologist.—T. W. Kirkpatrick, M.A., Dipl. Agric. (Cantab.), F.R.E.S.

Soil Chemist.—G. Milne, M.Sc., F.I.C.

Biochemist.—R. R. Le G. Worsley, A.R.C.S., B.Sc., Ph.D., D.I.C.

Plant Physiologist.—F. J. Nutman, A.R.C.S., M.Sc., D.I.C.

Plant Physiologist (2).—J. Glover, M.Sc. (Botany).

Plant Geneticist.—L. R. Doughty, B.Sc. (Agric.), N.D.A.

Botanist.—P. J. Greenway, F.L.S.

Superintendent of Plantations.—F. M. Rogers.

Secretary and Librarian.—R. E. Moreau, C.M.Z.S., M.B.O.U.

Assistant Superintendent of Plantations.—*Vacant.*

Assistant Secretary and Librarian.—W. M. Nutter.

Engineer Mechanic.—T. V. Greenwood.

Laboratory Assistant (Plant Path.).—R. F. W. Nichols.

Laboratory Assistant (Soil Chem.).—W. E. Calton, B.A., Dipl. Agric.

STAFF CHANGES.

Mr. A. G. G. Hill assumed charge of the Station on 16th November, 1937. Mr. J. Glover joined the staff on 2nd June, 1937. Mr. R. Bergner resigned at the end of April, 1937.

LEAVE MOVEMENTS DURING THE YEAR.

	Departed.	*Returned.*
Mr. T. W. Kirkpatrick ...	30th March, 1937.	16th November, 1937.
Mr. F. J. Nutman ...	27th July, 1937.	—
Mr. P. J. Greenway ...	26th October, 1937.	—
Mr. G. Milne	29th October, 1937.	—

REPORT OF DIRECTOR.

This report is for the nine months period 1st April, to 31st December, 1937, in order that future reports shall correspond with the calendar year and be brought into line with the departmental reports of the East African Governments As I assumed duty on 16th November I was in charge of the station for only six weeks of this period. I wish to pay a tribute here to Dr. H. H. Storey who, although saddled with the onerous duties of Acting Director for ten months prior to my arrival, continued to guide and keep touch with the research work of his section during that time, no small achievement.

In May, while on leave, I was privileged to attend the meeting of the Standing Committee on Agriculture of the Colonial Advisory Council at which the future research programme of the East African Agricultural Research Station was discussed prior to being submitted to the Council. This programme, which has now been sanctioned and is being put into operation, provides that this station shall continue to concentrate on problems of major importance to the agriculture of East Africa, research work of a fundamental character being the main objective. However, specific agricultural investigations may be carried out should circumstances at any time demand it. This research programme is published in the Report of Sir Frank Stockdale, K.C.M.G., C.B.E., on his visit to East Africa in 1937 (C.A.C. 345).

In August a meeting of the East African Directors of Agriculture took place at Amani, in connection with the second meeting of the East African Coffee Producers' Committee. As a result an important step towards the co-ordination of agricultural research in East Africa was taken. Proposals were accepted for the formation of an Interterritorial Coffee Research Committee, with the Director of Amani as Chairman, to advise the various Governments concerned on questions relating to the co-ordination and direction of coffee research, both fundamental and applied. These proposals have now been implemented and the first meeting called for a date early in 1938.

I am greatly indebted to the Directors of Agriculture in all the East African Dependencies for their ever-ready assistance and co-operation. The continued close co-operation between the Amani staff and that of the Coffee Research Station, Lyamungu, and the Sisal Research Station, Mlingano, is of great mutual value, particularly in connection with plant-breeding and selection.

Research.

The appended scientific reports of research officers and the list of recent publications in Appendix B attest the steady progress that has been made during the past nine months.

The work of the Plant Pathology section has, as in the past, been chiefly concerned with investigations into the mechanism by which insects transmit virus diseases of plants, particularly cassava and maize. This work, apart from its value as fundamental research, is of great economic importance, particularly in connection with the control of Mosaic diseases amongst native food crops in both East and West Africa, where the losses due to this group of diseases are very large. These investigations are proceeding concurrently with the breeding of resistant cassava types by the Plant Pathologist, while at the same time close co-operation is being maintained, by correspondence and visits, with the Departments of Agriculture in Tanganyika, Zanzibar and Kenya which are engaged on other features of the problem. In connection with this breeding work the successful crossing of cassava with Ceara rubber is reported for the first time.

In December the Plant Pathologist revisited Zanzibar to continue his investigations into, and to advise on the methods to be adopted to solve, the problem of Sudden-Death Disease of clove trees. A special research officer is now to be appointed to Zanzibar to investigate this problem while, in the meantime, the possibility of the existence of a toxic element, or a mineral deficiency, is being investigated by spectrographic analysis.

On his return from leave, towards the end of the year, the Entomologist continued his investigations on the ecology of coffee plantations, concentrating on the study of the various leaf-miners that infest coffee and the relationship of the numerous parasites attacking them.

Soil studies, as in the past, have been confined largely to reconnaissance surveys of the soil types of East Africa, chiefly of Tanganyika Territory. It is proposed to extend this valuable work to Kenya and Uganda as soon as opportunity allows. The value of this research lies in the prospect of achieving better land utilization and management in future and of avoiding past errors.

Mr. Milne has now left for the West Indies and the United States of America, on study leave, having been awarded a grant for the purpose by the Trustees of the Carnegie Corporation of New York.

The staff of the Plant Physiology section was strengthened during the year by the appointment of a second physiologist. This appointment will make possible the much needed extension of physiological work to other crops besides *C. arabica,* particularly *C. robusta* and sisal. Shortly after assuming duty the second physiologist began investigations on the root system of sisal to determine its relationship to the various soil types, as a basis for future physiological work on the water-relations of this crop about which so little is known.

In his report below Mr. Nutman, as the result of ten years' work, reviews the position that plant physiology now occupies in relation to tropical agriculture and emphasises the fact that the success of future work depends largely on the development of suitable apparatus. During preliminary enquiries while in the United Kingdom, into methods and apparatus for the measurements of photosynthesis in a complete coffee tree, Mr. Nutman has received the greatest assistance from various authorities, especially at the National Physical Laboratories.

The progress reported by the Geneticist in the breeding and selection of Agaves and coffee is encouraging. This work, although of necessity very slow owing to the nature of the crops dealt with, is of considerable economic promise as is always the case when unimproved crops are dealt with by the trained plant-breeder. The possibilities of agave breeding have been extended of late by the recent indications that in future there will be a market for an increased range of fibres, particularly of the shorter and finer types, so that new hybrids and selections with fibre characters which we have previously regarded as undesirable may now be of value to the industry. The arrangement whereby our newly produced fibres are to be tested at the Linen Industry Research Station at Lambeg, Ulster, will be of much assistance to us in this connection.

The work of the Biochemist during the year has been almost entirely confined to investigations into the toxic principle of the vegetable insecticides Derris and Mundulea.

In addition to his numerous routine duties, the Botanist spent three months of the year on the island of Mafia studying the relationship of its vegetation with that of Zanzibar, Pemba and the East African mainland. The *Swahili Dictionary of Plant Names* compiled by him and published by the Government of Tanganyika has been much appreciated and the first edition sold out.

Mr. Moreau's publications during the year have again added considerably to the knowledge of the East African avifauna. The chief aim of his work is the study of bird distribution and differentiation with regard to isolation, the latter being measured in terms of climate and vegetation and not merely distance.

Administration.

During the year the Governments of Tanganyika, Uganda and Kenya made small proportionate increases in their previous contributions, in order to cover the cost of the second physiologist, who was added to the staff in June. Postponement of travelling and works, and other factors, enabled the expenditure during the year to be kept within the current revenue. It is a matter for

great satisfaction that from 1938 three of the East African Governments have agreed to make substantial increases in their contributions; the new total will enable a reasonable amount of travelling to be done by the staff, for the first time for a number of years, and also make it possible to initiate a long overdue scheme of adequate housing for the native employees.

In addition to undertaking the usual maintenance and repairs to buildings the Engineer completed several major works during the year, the chief of these being the extension of the Biochemist's laboratory, the building of a combined transformer house, store and office and the complete reorganization of the overhead low-tension electrical distribution system to comply with the new Government regulations. In addition, two excellent lorry bodies were built for Bedford chassis. The replacement of the mud huts in the labourers' camps by concrete and iron houses was begun in November, this being part of a five-year scheme for the improvement of the housing conditions of the junior employees and labourers on Amani.

As in the past the library was maintained wholly from the income derived from the £10,000 grant of the Carnegie Trust Fund made in 1934, almost the whole of the expenditure being on scientific periodicals.

The Secretary and Librarian, in addition to his other duties, has now been appointed Assistant Editor of the *East African Agricultural Journal.*

At the meeting of Directors of Agriculture held at Amani in August, 1937, it was agreed that the East African Agricultural Research Station, being intended for fundamental research, should not normally answer practical enquiries from planters but should refer these, with any relevant notes available, to the Department of Agriculture concerned.

A duplicating machine was purchased during the year with the object of circulating important scientific results as expeditiously as possible to officers in East African Agricultural Departments.

In the interests of economy the experiment of substituting two junior African clerks for a trained European stenographer is being tried. It is still uncertain whether the experiment will be a success.

Amani Plantations.

The management of the Kwamkoro Estate Redevelopment Scheme by the Superintendent of Plantations, Amani, during the past few years has been largely at the expense of the Amani plantations; but with the forthcoming appointment of an Assistant Superintendent it will be possible to manage both areas

adequately. In this connection it may be added that the methods used for costing, recording crop operations and yields and the utilization of the available labour supply are in the process of being reorganized. Details of the work done on the plantations appear on pages 32-36.

Plant Introduction and Distribution.

The greenhouses of the East African Central Quarantine Station in charge of the Plant Pathologist at Amani have been filled to capacity during most of the year, chiefly with sugar-canes, cassava and succulents.

Considerable quantities of seeds and planting material of various crops were distributed during the year, chiefly Blue Sisal, Derris, Cinchona and Aleurites. In addition, and very numerous requests for small quantities of seed of the various uncommon plants and trees established here were met, as usual. Sisal weevil larvae having been reported in bulbils from the Sigi nursery in December, distribution of sisal bulbils was stopped pending investigations.

The Redevelopment of Kwamkoro Estate.

The above scheme, fully described in the last annual report, entered upon a critical phase in 1937 owing to the rapidly approaching exhaustion of the special grant provided in 1935 from the Colonial Development Fund. Unforeseen expenditure was necessarily incurred on various items in 1935 and 1936, so that additional funds will be necessary if the scheme is to be brought to fruition.

Since April, 1937, rapid progress has been made with the planting programme and at the beginning of 1938 only 10 acres of robusta coffee and 24 acres of cinchona remained to be established. This work should be completed early in 1938, by which time the following crops will have been established: cinchona, 100 acres; coffee, 120 acres; Tung oil, 108 acres; and Derris, 10 acres. It is too early at this stage to draw any conclusions from these young plantations, excepting that it has been shown that comparatively large areas of promising crops can be established on land which is typical of much of the impoverished Usambara region. Great interest has been shown in the experiments by visiting planters, particularly in regard to Derris, Aleurites and Cinchona culture, so that the demand for planting material usually exceeds the supply.

The East African Agricultural Journal.

The editing of this journal, of which six numbers are published annually, occupies a considerable proportion of the time of the Director and Secretary, who act as Editor and Assistant

Editor respectively, with a second Assistant Editor, mainly for proof-reading, at Nairobi, where the printing and distribution are done.

It is pleasing to report that contributions to the journal have come in steadily during the greater part of the year, from both officials and planters, and that the circulation reached 833 copies. The journal forms a very useful medium for the expeditious circulation of scientific results which might otherwise only appear in departmental reports not usually seen by the public.

A. GLENDON HILL,
Director.

Amani,
March, 1938.

PLANT PATHOLOGY.

The duties of the Acting Director, performed during the whole of 1937 up to November, allowed me little opportunity to prosecute research. My assistant, Mr. R. F. W. Nichols, has however been on duty during the full period and has been chiefly occupied with virus diseases of cassava, in which advances have been made.

Virus Diseases of Plants.

The mechanism of transmission by insects.

Work under this heading has been confined mainly to experimental studies intended to clarify minor obscure points and to the preparation for publication of accounts of work already done. The first of a series of papers dealing with recent studies on the inoculation of the streak virus into maize by *Cicadulina mbila* has been accepted for publication in the Proceedings of the Royal Society. This paper deals generally with the conditions that determine whether infection or failure follows from the contact of a virus-carrying insect with a plant. I expect to follow it in 1938 with a paper describing studies of the salivary excretion by the insect and the part played by the saliva in virus-inoculation.

I hope also during 1938 to complete for publication an account of the breeding studies of *Cicadulina mbila,* to which reference was made in my last report.

A curious point in the behaviour of *Cicadulina mbila,* observed incidentally during our studies, was considered worth description in a short note, which has appeared in the Proceedings of the Royal Entomological Society. We found that this insect defaecated, not only the well-known honey-dew, but also a second kind of fluid, which was disposed of by spreading on the wings until dry, when it was scraped off as a powder.

Cassava Virus Diseases.

In his report on a visit to East Africa Sir Frank Stockdale stressed the importance of work in the improvement of cassava and particularly in the control of the virus diseases that seriously reduce its production. He recommended the fullest co-operation by Amani with Agricultural Departments in the search for cassava varieties resistant to these diseases.

It is appropriate to discuss the form that co-operation can take. I assume that, as in the past, the experiment stations will concentrate upon testing in each district the resistance of varieties established locally and supplied to them from elsewhere. Up to a point this is straightforward work, and duplication in as many centres as possible is entirely desirable. Amani can appropriately advise on the technique to be followed in testing. It is desirable that Amani should be supplied with the full data of all trials carried out. Thus Amani would function as a clearing-house for information on the behaviour of varieties and also as a distributing-centre for the material showing the most promise. It has in fact been performing the last function for some time, particularly in regard to imported varieties.

The Director of Agriculture, Tanganyika, has undertaken at the Morogoro Experiment Station the larger project of raising seedlings and their selection for resistance. A meeting of Directors of Agriculture in August, 1937, recommended that other Departments should look to Morogoro as the centre for this work. Since my visit to Morogoro in 1934, the work has proceeded along lines recommended at that time. I have maintained touch by correspondence with the officers concerned, and I revisited the station in 1937. It is desirable that I should visit Morogoro at least once a year in the future.

The type of work hitherto considered is properly that of Agricultural Departments and I have not contemplated duplicating it at Amani. But Amani may appropriately contribute by undertaking more exact breeding studies, by controlled crossing and particularly by interspecific hybridization. Later, when the groundwork has been done, it may be advisable to transfer this work to Morogoro. Meanwhile a start has been made.

Besides a large collection of cassava types, both of local origin, supplied by Agricultural Departments in Uganda, Kenya and Zanzibar, and imported from overseas, we have the following species of Manihot available for crossing:—

M. glaziovii, Ceara rubber.

M. dichotoma(?), two types, from an early German importation.

M. heptaphylla, recently imported from America.

Several hundred controlled pollinations have been performed by Mr. Nichols, with the assistance and advice of the Station

Geneticist. Considerable information has been accumulated on the technique of crossing and germination of the seeds. At the time of writing, I can report our first successful germinations of seed of Ceara X cassava and *M. dichotoma* X cassava crosses.

This breeding programme will require the development of a considerable area of land. For the maintenance of stocks of cassava varieties Amani is well suited, since the infection-rate is low and mosaic can be easily controlled by rogueing. But it will also be necessary to carry out our own preliminary resistance trials on the hybrid material; and this must be done in an area of high mosaic infection. It will thus be necessary to develop a testing-ground perhaps at the Sisal Experiment Station at Mlingano (the authorities in charge of which have already provided facilities for cassava experiments), at the old Tengeni experiment station, or preferably in the foothills nearer to Amani.

The introduction of exotic varieties of cassava through quarantine has continued. In all we have now introduced 67 varieties from the Gold Coast, Trinidad, Jamaica, Mauritius, Madagascar, Java and the Malay States. Of these 49 have been successfully established, although as yet only 16 have been multiplied sufficiently to allow of distribution to Departmental stations. We have now a representative collection and there is little point in adding to it indiscriminately. Further importations will be restricted to types that have shown evidence of resistance in their country of origin, and in particular to the resistant types recently developed in West Africa, in the hope that some may yet carry a factor for resistance to the East African viruses.

Turning to the more fundamental studies of the cassava viruses, I am able to report an important advance in knowledge of the insect-transmission of the mosaic group. In early reports I have referred to the successful transmission by a White Fly, determined by different authorities as *Bemisia gossypiperda* or *Bemisia nigeriensis*. At first success was obtained only by exposing whole plants to many insects and all attempts to confine the insects to parts of the plants resulted in failure. We have now found that transmission will occur only if the insects feed on a young leaf, that has not yet enlarged to its full size, and only if this leaf remains alive attached to the plant for not less than about eight days. A convenient greenhouse technique has been developed that satisfies these conditions, and by its use experiments are almost invariably successful.

The study of the strains of the mosaic virus has continued on the lines previously described. Although minor differences in symptoms have been observed between a number of strains, we have decided that no useful purpose would be served by

their separation beyond the two groups of severe and mild strains. At present we have no better criterion for differentiation than the symptom picture, and so great are the symptom-variations induced by environmental and other factors that a fine differentiation is possible only under the artificial conditions of the greenhouse. Our two main groups however may usually be recognized in the field without difficulty.

The existence of strains of the mosaic virus has considerable practical importance and may add greatly to the difficulties of control. While I believe that we have exhausted the possibilities of differentiation by symptoms, there remains the danger that strains, indistinguishable by the symptoms they produce, may have varying virulence to different varieties of cassava. As I have already reported (Seventh Annual Report, 1934-5, p. 14), the strains existing in West Africa and those in Amani appear to differ in this respect. The breeding programme at Amani may provide us with differential hosts, by the use of which the classification of the local mosaic strains may be placed on a firmer basis.

We have successfully transmitted both severe and mild strains of mosaic with the White Fly.

I have already reported the failure of the naturally occurring mild strains to confer immunity against severe strains (Seventh Annual Report, 1934-5, p. 14). In continuation of this line of study we have attempted to attenuate severe strains by heat-treatment, in the hope that so treated they might be more effective in conferring immunity. These attempts have been unsuccessful.

The evidence that insect-transmission can occur only through the very young leaves at the shoot-tip led to the suggestion that a small change in the eco-climate of the plant might cause the insects not to frequent these leaves. The White Fly can certainly maintain itself on the older leaves of cassava, so that there is at least a theoretical possibility that a plant might carry a heavy infestation, and yet, if the infestation was confined to the older leaves, it might escape mosaic-infection. A preliminary plot experiment, to test the influence on infection of three different ground-covers, has been laid out at the Sisal Experiment Station, Ngomeni. I am indebted to the Board of Management and to the officer in charge for providing facilities for this experiment. An account of the field transmission experiment at Kiwanda (Ninth Annual Report, 1936-7, p. 19) will shortly appear in the *East African Agricultural Journal*.

A paper on the Amani studies of the mosaic viruses of cassava is now in draft and should be published during 1938.

The vector of the brown-streak virus of cassava still remains to be found. It seems nearly certain that the White Fly cannot act as vector of this virus. A trial of a mealy-bug that occurs on cassava was unsuccessful.

Although economically the mosaic group of viruses are the most important in East Africa, and there is good reason to concentrate at first on breeding for resistance to them, it would be a mistake to disregard the brown-streak virus. This virus can, under conditions favourable to it, cause a total loss of the crop, which a mosaic virus will never do. Fortunately these conditions are not usually encountered in the areas where cassava is grown and the severe manifestation of the disease has been seen so far only in Amani during the colder months. Nevertheless this disease seems to be as prevalent as mosaic in Zanzibar and the Tanganyika coastal belt; and it undoubtedly plays a part in the degeneration of the crop. One effect, recognized only during the past year, is on the development of cuttings; the disease destroys many of the buds and diseased cuttings often fail to produce shoots.

" Sudden-Death " of the Clove Tree.

Following my visit to Zanzibar in July, 1937, the Agricultural Department undertook certain experimental treatments of healthy clove trees and compared the resulting effects on the trees with the symptoms of the disease known as " sudden-death." In December, 1937, I revisited Zanzibar to carry out observations suggested by the results of these experiments. Although an explanation of the cause of sudden-death has not been immediately forthcoming, the data so obtained may provide a basis for the investigations of the special research officer to be appointed.

Following another line of investigation, suggested by Sir Frank Stockdale, I have been able to make arrangements for spectrographic analysis of clove material, for the purpose of deciding whether sudden-death could be attributed to the lack of an essential element or to the presence of a toxic one. Material will be collected by the Zanzibar Agricultural Department and the analyses will be performed at the Imperial Chemical Industries' Research at Jealott's Hill. This arrangement has been rendered possible through greatly appreciated co-operation of Mr. W. V. Blewitt, of Imperial Chemical Industries.

General.

During part of December, 1937, Dr. W. Carter, of the University of Hawaii, visited Amani in order to undertake investigations of the symbionts in the mycetomes of *Cicadulina mbila*. Dr. Carter will publish the results of these studies, which are of great fundamental interest and may prove to bear some relation to the ability of an insect to transmit a virus.

H. H. STOREY,
Plant Pathologist.

ENTOMOLOGY.

I returned from leave on 15th November. There are, therefore, only six weeks of the period under review on which to report. In accordance with the recommendations made at the 34th Meeting of the Colonial Advisory Council of Agriculture and Animal Health, held on 29th June, 1937, work on the ecology of coffee plantations is to be continued by detailed studies of particular insects of importance.

After consulting Sir Guy Marshall, while I was on leave, I have therefore started an investigation into the various leaf-miners (principally *Leucoptera* spp.) that infest coffee.

The first step is to gain a knowledge of the inter-relationship of the many species of parasites attacking the leaf-miners. It is already clear that this is a complicated subject that may prove difficult to elucidate.

Publications.—" Colour vision in the triungulin larva of a Strepsipteron " appeared in the *Proceedings of the Royal Entomological Society of London,* Vol. 12, part 3.

" The autecology of *Antestia* spp., with a particular account of a Strepsipterous parasite " was published as Part 14 of Volume 86 of the Transactions of the same Society.

T. W. KIRKPATRICK,
Entomologist.

SOIL CHEMISTRY.

Soil Reconnaissance.

In earlier Annual Reports work of this kind has been reported under the heading *General Survey and Classification.* The word *survey,* however, used of soil work in the field, implies systematically covering a piece of country by a network of exact observation. In this sense soil survey has not yet been begun in any of the East African dependencies. It seems best, therefore, to reserve the word for the more proper use that awaits it in the future, and in the meantime not to disguise the fact that we are only *reconnoitring* our soil types as opportunity arises.

In several districts not hitherto touched, the opportunity has arisen this year by the chance that workers in other scientific fields, travelling for their own purposes, have taken an interest in soils; and in other areas in which brief reconnaissances from Amani had already been carried out, the tentative sketches of soil conditions that resulted have been amplified and corrected by material gathered more at leisure, and in the light of our preliminary results, by outside workers for handling here. Collaboration of this kind is very satisfactory to record, and represents perhaps the ideal way in which the scope of the reconnaissance work should expand, for it removes the study of the

soil in the field from being mistakenly looked upon as a mystery to be practised only by specialists. The volume of material being received for laboratory examination from these sources, added to that collected by ourselves, is now such that further qualified assistance in handling it is necessary if the collaboration on our side is not to fail through delay in reporting.

In 1936 Mr. D. Vesey Fitzgerald, Government Entomologist to the Colony of the Seychelles, spent some weeks in Mafia Island, which lies in lat. 8° S. off the delta of the Rufiji River and is administered as a District of Tanganyika Territory. During his stay at Amani later that year he was able to review his Mafia soil observations after having seen material from kindred soil types of Zanzibar and the mainland coast belt in the Amani collections. In June, 1937, I received from him a sketch-map of the soil distribution, a tentative classification of the soil types, and notes on the geology, hydrology, vegetation and crops. These valuable papers were circulated with his consent to the three Departments of Agriculture likely to be interested (Zanzibar, Tanganyika, Kenya). When in August, 1937, Mr. Greenway, the Amani Botanist, visited Mafia, Mr. Fitgerald's map and notes formed a basis on which he collected a number of soil profiles, which were received at Amani in October and will be worked on in the laboratory in due course.

In January, 1936, I had visited under guidance of the Agricultural Officer at Mwanza, (Mr. D. Thornton) a newly-opened experiment-centre at Nyamahono, on the West side of Smith Sound, Lake Victoria, and had made a collection of the local soil types, which were reported on provisionally in a section of my Soil Reconnaissance Report of November, 1936 (see references in the Seventh and Eighth Annual Reports). Nyamahono lies in Uzinza, a country of complex topography included between Smith Sound on the East, Emin Pasha Gulf on the West, and lat. 3° S. In February-March, 1937, and further in June, 1937, Uzinza was investigated from the point of view of vegetation and tsetse ecology by Mr. B. D. Burtt, Survey Botanist to the Tsetse Research Department of Tanganyika Territory. He made notes of the soils seen along the routes of his journeys, and sent to Amani complete samplings from 21 profile-pits, together with sketch maps, notes on crops, and in due course copies of his ecological reports. His collections of February-March (11 profiles) were reported on by me provisionally in August ("Preliminary Notes on the Soils of Uzinza", circulated in typescript), and they and the remaining samples, received later, have since been worked on in the laboratory with a view to a further report. My Nyamahono samplings, together with earlier collections in Northern Usukuma (East of Smith Sound) and in the Kahama District, prove to represent soil types of general occurrence in Eastern Uzinza, where the parent rock is granite. This correlation with soil

types of known agricultural behaviour should be useful in guiding land utilization in Uzinza, which is very sparsely inhabited but is receiving immigrants (and will receive more if tsetse can be eliminated) from adjacent overpopulated districts.

In Western Uzinza, on the banded ironstones of the Upper Basement Complex, a new range of types, mostly of unpromising character agriculturally, has been revealed by Mr. Burtt's collections.

My visit to Tabora District in late January, 1936, was of three days only, and though it served for a preliminary reconnaissance in company with Mr. R. D. Linton, Agricultural Officer (reported on in November, 1936), no soil sampling was then done. This has since been undertaken by Mr. Linton, whose representative collection of profiles was received at Amani in October, 1937. After my departure on leave Mr. Calton began work on these (November-December, 1937) and the results will be reported on my return.

Analytical work has also been done on the collection of soil samples from the volcanic upland area of Oldeani (between Lake Eyasi and Lake Manyara, in North-Central Tanganyika) and adjacent Rift Valley districts, made by Mr. H. B. Stent, Soil Chemist to the Lyamungu Coffee Experiment Station, in November, 1935.

A short visit to Morogoro in June gave me the opportunity of collecting material representing the soils of the Kingolwira Experiment Station, and of parts of the Uluguru foothills for which I had no records, towards Ngerengere on the East and Mlali on the South-West. On the return journey I was much assisted in understanding the soils along the foot of the escarpment of the Nguru Hills, by Mr. E. W. Pennefather, engineer of the Public Works Department in charge of reconstruction of the trunk road Morogoro-Turiani, who showed me many fresh exposures in borrow-pits; and I was able to give him some help in the choice of sites from which to obtain suitable earths for road-surfacing.

Between 25th September and 11th October, I made a soil reconnaissance in an area centring on Kitivo, at the North-Eastern foot of the West Usambara massif. A report on this reconnaissance has been submitted.

A journey in Uganda intended for August and September, 1937, for which arrangements were partly completed, was postponed owing to pressure of other work, and is to be undertaken at the end of 1938.

Failure of grain crops on certain newly-cleared bush lands.

In 1936 this question was raised by Mr. N. V. Rounce, then Agricultural Officer at Morogoro (East African Agricultural Journal, 2, 145-148, 1936) as presenting problems in cultivation methods and choice of first crop on certain soil types in some

extensive areas of native agriculture. It has since been made the subject of a field experiment laid down by him on land cleared from *Acacia pallens—Combretum* sp.—*Panicum maximum* open savannah bush at Kingolwira Experiment Station near Morogoro. The experiment covers land cleared a year ago and cropped once with cotton, land newly cleared, and adjacent land not cleared; four crops (maize, cotton, sorghum, groundnuts) are being grown, each will have two treatments as to cultivation, and there is sixfold replication. A programme of soil analysis has been arranged, to be carried out at Amani, and the samples (top soils from 72 plots, and two profile pits) were received in June, at the time of my visit to Kingolwira already mentioned. Sampling is to continue in successive years of the experiment and the total amount of analytical work to be undertaken is very considerable, though it is necessarily curtailed by the fact that certain desirable lines of chemical investigation, on fresh soil samples, are rendered impracticable by the 200-odd miles that separate the field experiment from the laboratory. It is hoped that light will be thrown on the soil changes that take place when virgin savannah land (as distinct from land under forest or closed bush types) is broken for annual-crop cultivation.

Lime carbonate in termite mounds.

Further data on the accumulation of lime carbonate in certain types of termite mounds have been obtained during the year. Mr. R. D. Linton had a typical large mound at Tabora excavated and sampled from periphery to core in some detail, and the samples have been received and analysed at Amani. Material was sent also from the Lindi Province, the calcareous earth of the mounds and the hard limestone of the core having attracted the interest of a Public Works Department road engineer. In districts of acid soils where these large calcareous mounds occur at the rate of two or more per acre, it seems clear that the termite has had a considerable adverse effect on the lime-status of the soil of the surrounding land, as the earthy part of the heap alone contains the equivalent of a heavy agricultural dressing of lime which would, but for the insect's activities, have remained generally distributed; and the hard core contains many times as much. So far as I can find, the subject has had no mention in the published literature of termites. The phenomenon is not confined to African mound-builders, for a letter received from a soil worker in Siam (Mr. R. L. Pendleton) mentions that it has engaged his attention there as an important factor in soil genesis and fertility.

Soil Colour.

A short period of laboratory work was devoted to testing the spinning-disc method of specifying soil colour, in terms of percentages of four standard colours (black, white, red, yellow),

in continuation of a programme begun last year. The method proves to be fairly generally applicable, except for some difficulty with incoherent sandy soils and clays with very high shrinkage; and it will serve to reduce the personal factor in the description of this important physical property.

Publications.

Two articles were written continuing the series *Essays in Applied Pedology* for the *East African Agricultural Journal,* on Bukoba soils and on factors in soil mechanics respectively.

Study Leave.

Permission to undertake a study-leave journey of about seven months duration to the West Indies and to the United States with the aid of a grant from the Trustees of the Carnegie Corporation was given in May. In order to be able to embark on this early in 1938, I left the Station on vacation leave at the end of October, and Mr. Calton took over charge of the laboratory.

G. MILNE,
Soil Chemist.

BIOCHEMISTRY.

Shortly after my return from leave in February, 1937, I submitted a draft five-year research programme, since approved, which included a thorough examination of the biochemistry of the toxic constituents of various vegetable insecticides, in particular derris and mundulea with a view to determining the location, the method of formation and the use to the plant of its toxic substances. In addition, field work such as manurial trials, different ages and times of harvesting, etc., is to be carried out with these plants.

In conjunction with Mr. Nutman, Plant Physiologist, the first step in this programme was undertaken and a paper entitled *The Histology of Rotenone in Derris elliptica* published. In this paper we have shown that rotenone, the chief toxic constituent, can occur in any of the xylem parenchyma cells, and we have traced its production from its first appearance in the root when about six weeks old, to its final state in the mature plant.

Since then I have carried out similar work on Mundulea, but this has necessitated considerably more work, as the barks of both root and stem and also the flowers and seed have had to be examined. Except for a few outstanding points requiring elucidation, these results are now ready for writing up.

As regards field work, I have examined a number of derris samples from Kwamkoro and from some private estates in order to ascertain the course of toxicity with age, etc. It would

appear from the results that locally the best age for harvesting, in order to obtain the highest yield of good quality root, is from $2\frac{1}{2}$ to 3 years compared with 2 years, or less, as recommended in Malaya.

A fairly large scale plot experiment has just been started consisting of sixty blocks with twenty derris plants in each, thirty blocks to be staked when ready and thirty left unstaked. After 18 months five blocks of each will be dug and analysed for rotenone, yield of root, etc., and at 21, 24, 30 and 42 months five further blocks of each will be dug. Each block of 20 plants will be treated as one sample and there will thus be five samples of both staked and unstaked plants from each digging. From this experiment I hope to get a good idea of the best age for digging the roots and also the effect of staking as preliminary results appear to show a greatly improved yield of root from staked plants.

Results to date do not indicate any difference in toxicity of plants due to the time of year in which they are dug, but I am laying out a further plot experiment to verify this point. Blocks of derris will be planted out regularly on the same date each month, for twelve months, and they will be dug exactly two years later: thus I shall have a series of roots two years old but harvested at monthly intervals throughout the year. In this way any appreciable seasonal change should be seen.

Mundulea on the other hand appeared to show an appreciable seasonal change as regards the first samples collected from Moa, and I therefore considered it essential to investigate this point at once, as seasonal variation would vitiate the results obtained. The only suitable plants for this investigation were some three year old ones growing on the Sisal Experimental Station at Mlingano. I have taken mixed samples of bark from these trees each month for ten months, and have not found any significant difference in rotenone content. It would thus appear that seasonal differences do not exist. The original differences at Moa were probably due to the fact that the same trees could not be sampled each time, as whole trees were cut down.

During the year I examined and reported on a number of essential oils, especially citrus oils, which were sent to me.

R. R. WORSLEY.
Biochemist.

PHYSIOLOGY.

After ten years' work it seems appropriate to review the position of physiological research, not so much from the point of view of what has been accomplished or even of what has been planned, but from the philosophical standpoint. Ten years ago no physiological research worth mentioning was in progress in the tropics; little was known of problems of tropical

agriculture that might be solved by physiological means; and the relation between physiology and crop production was very vague.

During these ten years, the agriculturist has found that physiological knowledge is essential to the solution of many of his problems. The truth of this statement can be seen by reference to any series of Colonial Agricultural Annual reports; and confirmation given by the increasing call for physiological results. The physiologist on the other hand, has learnt the main problems requiring attention and, in some instances the kind of information most likely to contribute to their solutions. The preparation of a research programme this year has enabled one of us to put forward his opinion of the kind of physiological work that Amani should undertake.

There is no descriptive term for the type of work I advocate, and I propose to call it " Ecological Physiology ". I would define it as the study of the physiology of a plant in relation to the environmental factors, with the proviso that, so far as our work is concerned, the physiological behaviour of the plant should be considered to be an end in itself. My meaning may perhaps be clarified by an example from my past work on the effect of shade on coffee. It has been shown that:—

(*a*) Photosynthesis in coffee is favoured by light up to an intensity of about 0·7 g./cals/sq. cm./min. Above this intensity, photosynthesis is depressed.

(*b*) This can be explained by the stomatal behaviour of the plant.

(*c*) Stomata of coffee, in general, are mainly affected by light. Other factors influencing stomatal movement do not normally operate.

This gives information on the relation between the plant and its surroundings, but leaves unknown the mechanism whereby light operates on the stomata, a problem which should in my opinion be left to the more academic worker.

The adoption of the sort of work I have called " Ecological physiology " necessarily involves field work, often under conditions that are exacting for both apparatus and worker: and little of this has been done anywhere, even in temperate regions, especially on the types of crop-plants to be met with in Africa. Field physiology has naturally lagged behind laboratory researches, even in temperate regions, and apparatus and methods are not standardized and are normally invented for each particular research as required.

Therein lies a great difficulty for tropical workers. Apparatus appropriate to any particular research can rarely be obtained: it must be developed for each purpose; and Central Africa is very unsuitable for the working out of new field methods. The time necessary for the development of a method may be ten

times as long as the research itself. By using to the full the facilities afforded by certain Research Stations in England much of this work may be expedited. But much must be done by the worker himself, whether in Africa or in Europe.

Coffee.

As a natural sequel to work on the Carbon Balance of single leaves, reported on previously, attention is being directed to the measurement of the assimilation of complete coffee trees under field conditions. Work in Amani during May and June showed the practicability of such measurements, and work during leave on suitable apparatus was planned.

Work on the stomatal behaviour of *robusta* coffee has started. It is proving a complex problem and shows points of dissimilarity with that of *C. arabica*. It is noteworthy that *C. robusta* exhibits the same rapidity of stomatal movement as does *arabica*: and it seems possible that their stomatal mechanism may differ from that of temperate plants.

In collaboration with the Biochemist, a very comprehensive and elaborate experiment on the nutrition of the coffee tree has been planned. This experiment will be lengthy, expensive, and difficult: but it should provide the knowledge essential to the proper understanding of the coffee crop. It is not yet known whether this experiment can be undertaken as special funds will be needed.

Sisal.

Work on the sisal fibre has ceased; and none is projected as routine tests are now undertaken by the Geneticist on his own behalf, and fibre research proper is in the hands of The Linen Industry Research Institute, Lambeg.

The appointment of a second physiologist who assumed duty on 2nd June, together with the cessation of work on sisal fibre, will enable physiological work on *Agaves* to begin. Preliminary work on the water relations of the plant has been done, and methods and apparatus tested.

F. J. NUTMAN,
Physiologist.

SISAL.

An investigation of the root system of sisal was started during the month of August. The purpose of the work was to study the relation of the root system to the various soil types on which the sisal plant is being grown and to provide a basis for future physiological work on the water relations of the plant. The investigation was carried out on various estates in the main sisal-growing areas. So far three main areas and nine soil types have been investigated; the coastal belt, the acid soils of the East Usambaras, and the calcareous soils at the base of Kilimanjaro, including one estate at Taveta, Kenya.

The results obtained indicate that sisal has a surface root system which is only slightly modified by soil conditions, the most important of which is the distribution of moisture in the soil. The typical system is characterised by greatest concentration of the feeding roots in the top thirty inches of soil while feeders in lesser concentration are found to a depth of four feet. The bearers which carry the feeders extend to distances ranging between three and fifteen feet radially from the plants. From data provided by Mr. W. E. Calton of the Amani staff, it appears that at least within very wide limits there is little or no correlation between soil acidity and root development. The soils investigated ranged between pH 5 and pH 9·85. In soil at pH 8·5 the root system of sisal was normal but at the extremely high value pH 9·85 the plants were poorly developed, the leaves were chlorotic and the root system much reduced.

As sisal is being grown mainly on the plains where the total annual rainfall is low and in many cases unevenly distributed throughout the year, the important problem of conservation of soil moisture arises. The " effective rainfall " is a governing factor in root growth, and the importance of the nature of the soil and its water-retaining capacity cannot be overestimated. In one soil which was extremely sandy and well drained, only the top 18 inches of soil held sufficient moisture for root growth. This was due to the presence of heavier soils, wind-blown from neighbouring areas, and a certain amount of decaying organic matter, both of which served to retain moisture which was otherwise rapidly drained away in the lower sandy layers. This area had a well-distributed, moderately high annual rainfall.

A second soil type, of loamy texture, in an area of less annual rainfall which was badly distributed, allowed the growth and fairly even distribution of feeding roots down to a depth of over six feet.

In neither of the two cases mentioned above was the position of the water table a factor in the supply of moisture to the root system.

The presence of hardpan and a high water table introduce slight modifications into the typical system mentioned above.

Among the complications introduced into the problem of " effective rainfall " and conservation of soil moisture is the factor of transpiration from weeds and cover crops. While " clean weeding " is apparently an ideal method of checking water loss by transpiration, it introduces the complicating factors of possible soil erosion and a certain loss by evaporation from the bare surface. In certain soils where the roots of the plant lie close to the surface, this latter factor, together with the possibility of high soil temperatures inhibiting the growth of roots, requires careful consideration. It is evident that some

form of weed control must be exerted both to reduce heavy soil moisture losses and the intense competition for nutrients between the roots of sisal and those of the weeds. Until more is known about the effect of " clean weeding " over a long period of years, improvement in agricultural practice seems to lie in the better spacing of the rows and the application of mechanical or other means to the closer control of weed growth.

A paper giving a detailed account of the above investigation is being prepared for publication.

The presence of black discolouration in baled sisal fibre was investigated and was found to be due to a black mould fungus developing on damp strands of the fibre. The sisal estate concerned has solved this problem by providing better drying facilities. This investigation has now ceased.

During the absence of the senior physiologist, routine work on the recording of stomatal movements in *C. robusta* and the recordings of a shade experiment were continued. Work was carried out on the development of apparatus for transpiration studies in coffee and sisal. A visit was paid to the Coffee Research Station at Lyamungu, where I saw the experiments being carried out on the rooting of cuttings by means of synthetic growth substances. I also visited various European and native coffee estates in the Kilimanjaro area. A visit was paid to an estate at Arusha where coffee trees are being prepared for future experiments on transpiration.

I wish to record my thanks to the owners and managers of the various sisal estates who have provided material and labour for the investigation of the root system of sisal, to the Senior Agricultural Officer i/c North-Eastern circle and to the Agricultural Officers who have assisted me with their specialised knowledge of the areas in which I worked.

J. GLOVER,
Second Physiologist.

PLANT GENETICS.

General.

1. During the nine months under review I paid several visits to sisal estates in the Tanga Province and also to the Sisal Experiment Station, Mlingano, in connection with my work on Agave.

2. In June I travelled with the Superintendent of Plantations to Nairobi where we staged an exhibit at the Nairobi Show of the Royal Agricultural and Horticultural Society of Kenya. The exhibit was designed to give some idea of the breeding work with Agave in progress at Amani. The fibre-strength testing machine was also exhibited and proved a great attraction to both European and Native visitors.

3. After the exhibition, we visited the Scott Agricultural Laboratories, the Plant Breeding Station at Njoro, and several estates in the Kiambu and Nakuru Districts and later Machakos.

4. On the return journey I visited the Coffee Research and Experiment Station at Lyamungu to inspect the plots of Arabica coffee that are being maintained in connection with my breeding work, and also visited the Taveta Sisal Estate.

Agaves.

5. With further accessions during the year, mainly gifts from Colonel the Hon. M. T. Boscawen, the total number of species and varieties of Agave represented in the collection is now 107. The more recent additions have not long been released from quarantine and are not yet planted in the field. Those in the field have, for the most part, made good growth but the heavy rains during the latter part of the year did not provide ideal conditions for the growth of Agaves and some of the small seedling plants had to be dug up and transferred to pots again to prevent them rotting.

6. Whenever there is sufficient material available, the various species of Agave are transferred to the Sisal Experiment Station for observation and propagation for possible breeding requirements. Several have been handed over during the year.

7. A small quantity of seed reputed to be from *A. lechuguilla,* the source of the Mexican " Tula " fibre, used in brush manufacture, was received from the Royal Botanic Gardens, Kew, and seedlings have been raised. Subsequently I received from Dr. A. L. Hershey of the State College, New Mexico, a large quantity of seed under the name of *A. lechuguilla* and I have raised a large number of seedlings. In the early stages of development there are no distinguishable differences between the two lots of seedlings.

8. The study of the development of *A. sisalana* has been continued and the observation plots were cut for the second time in September, 13 months after the first cut was taken. There are no striking results to record from these observations. Development between the two cuts has proceeded as predicted from a study of the earlier behaviour of the plants.

9. On the older plots (planted in 1932) some of the plants have poled but, contrary to expectation, a higher proportion of the recorded plants have poled in the plot on poorer soil where development was slower. On this plot 16 out of the 144 plants have flowered. The average number of leaves produced by the plants is 219 with a range of from 195 to 233 leaves. The data show that all the plants that have poled fall into the groups with the highest total leaf production.

10. By far the most interesting developmental records are those maintained by the staff of the Sisal Experiment Station on the hybrid families of *A. angustifolia* x *A. amaniensis* and reciprocals and the inbred seedlings of *A. amaniensis*. The hybrid families maintain an average leaf increase per plant about three times that of the inbred seedlings and very much higher than that of *A. sisalana* on the same estate. The officer in charge, G. W. Lock, has made some tentative selections from among the non-spiny margined forms of these hybrids, mainly on a basis of rapidity of development and size of leaf. An examination of their fibre qualities is still pending.

11. The further development of the plot of hybrids *A. angustifolia* x *A. sisalana,* cut for the first time in 1936 has been disappointing. Many have succumbed to the attack of the sisal weevil and the development of the others, after the first cut, has been slow. A second cut, taken in August, 1937, shows very much reduced yields of leaf, when compared with those of the first cut, although there is a strong relationship between the actual yields per plant at the two cuts; the higher yielders at the first cut maintaining their relative positions.

12. A first cut of leaf was taken in August from the recorded blocks on a field of seedlings of *A. sisalana* at Sigi. The leaf of the ten highest yielders in each of the three plots was decorticated on the Cormorant machine, but decortication was so bad that the samples proved useless for any comparative fibre tests. It is hoped that the machinery at the Sisal Experiment Station will have been installed by the time these plots are cut again and that assistance can be given to secure adequate decortication of the test samples. Where there are fairly large numbers of small samples to decorticate it is not reasonable to ask for the use of an estate factory as the time taken up in experimental work means a considerable financial loss to the estate.

13. The comparative trial *A. amaniensis* versus *A. sisalana* was cut for the second time in July, i.e., fifteen months after the first cut. There were again no significant differences in yield, both species yielding at a rate of about two tons of unbrushed fibre per acre. About 12 per cent. by weight of the leaf from the Amaniensis plots had to be discarded for sun-scorch damage whereas only 1·4 per cent. of the sisal leaf was seriously affected. I am greatly indebted to the manager of the Ngomeni Estate, Consolidated Sisal Estates of East Africa Limited, for his help in decorticating the leaf from these plots, and also to the Agricultural Officer and his Assistant from the Sisal Experiment Station for help in organizing the decortication of the separate lots of leaf and for help with the subsequent fibre weighing.

14. The fruits of the crosses reported in the last annual report were harvested in June. The success of the crosses varied very

widely, the most successful being those between two diploid species of Agave, i.e., *A. angustifolia* x *A. Lespinassei* and *A. amaniensis* x *A. Lespinassei*.

15. When small quantities of seed are obtained they are germinated in an incubator at a temperature of about 30° C. When there is an abundance of seed a series of samples are tested for germination and the balance of the seed sown in the nursery beds. I have noticed on previous occasions that some of the seed may remain dormant for several months and that long after transplanting the young seedlings from the beds many more seeds may still germinate. It has happened again this year. Seed of hybrids planted in boxes is still germinating six months after planting. A very large quantity of seed was obtained from the cross *A. angustifolia* x *A. Lespinassei* and, as most of this was not wanted for sowing, it was stored in the laboratory for some months on an open tray. Tests with the fresh seed gave a very slow germination, 64 per cent. in 138 days—only 10·5 per cent. in the first 29 days. Germination in the beds was correspondingly slow. Tests with the seed which had been stored for some months gave a germination of 83·5 per cent. in 23 days. This seems to indicate that storage for a time has a beneficial effect on the seed.

16. The successful use of *A. Lespinassei* as a pollinating agent has been mentioned previously (paragraph 14). The parent plant, on open pollination, produced many fruits but these yielded only two seeds. Both these seeds were put into the incubator in August. One was bad and rotted, the other is still firm and hard but has not yet germinated. This species at Mwera, Pangani, has also failed to set seed. The reason for this sterility is not obvious.

17. Fifteen plants of the first inbred generation of *A. angustifolia* planted in the field in April, 1933, are beginning to flower and it is intended to self these plants to raise a small inbred second generation. Unfortunately some of these plants have been lost owing to weevil damage at the base of the pole. Many of the flowers are abortive, the anthers being pushed out from the tip of the bud before they are mature and, failing to develop further, the buds eventually absciss. It is thought that this condition is brought about by unfavourable weather conditions during development. The principal interest in this family lies in the rapidity of growth and high total leaf production; an average of 446 leaves per plant for the 15 poling plants compared with an average of about 219 for *A. sisalana* and about 161 for *A. sisalana* seedlings, under similar conditions.

18. An interesting species of Agave, believed to be *A. decipiens* Baker, was found growing by the roadside at Kiambu, Kenya. It had rather short leaves set on a trunk about 12 feet tall. When found the plant was poling and I am indebted

to the Assistant Agricultural Officer at Kiambu for keeping the plant under observation during its flowering period. Unfortunately the pole was cut down by some agent, unknown, before the fruits had time to mature. Suckers from the plant were obtained, however, but it will be a long time before these plants reach the flowering stage. Chromosome counts in the root tips of this material show that it is a tetraploid species 2n = 4x = 120.

19. There has been no new material in flower during the nine months covered by this report and the only cytological investigations have been somatic counts for a few introduced species and the preparation of material of others.

Coffee.

20. All coffees in the field have made good growth during the year. Continued intensive treatment of the plots of *C. arabica* have resulted in the maintenance of steady development and have appreciably reduced the liability to die back. The recorded blocks of coffee have been extended by the inclusion of three plots of Robusta coffee on one of the Kwamkoro plantations planted with material raised from seed of selected parents. The Robusta harvest is not yet complete.

21. The high level of productivity of some of the selected Robusta parents is being maintained. Others have had all lateral branches removed in an endeavour to force the growth of new leading shoots ready for grafting and rooting of cuttings. On these yield records have had to be discontinued.

22. The plots of *C. arabica* grafted on to stocks of other species have given increased yields this season following a poor crop in 1936. As the plants were getting unwieldy and out of hand, they were cut back to a height of about one foot above ground level after the removal of the crop, and the new shoots are being thinned out to leave three per plant. The yields from the grafted plants are still considerably higher than those of *C. arabica* growing on its own roots under similar conditions and treatment, in the adjacent plots.

23. Of the crosses mentioned in the last report only the hybrid *C. arabica* x *C. eugenioides* succeeded. From this cross 16 plants were raised but one subsequently died. There are differences in appearance among these plants and it may be that some of them are *C. arabica* resulting from accidental pollination. Five plants show some leaf characters of *C. eugenioides,* three appear intermediate and seven are not distinguishable from *C. arabica* at this stage. The true hybrid should be easily detectable by chromosome counts in the root tip. As *C. arabica* has 44 chromosomes and *C. eugenioides* 22, the hybrids should be triploid with 33 chromosomes.

24. There is no doubt that the cross between *C. eugenioides* and *C. robusta* was successful, but owing to the depredations

of some animal or insect pest none of the seeds were harvested. Examination of the damaged fruits showed that the seeds inside were well-developed and not abortive.

25. During the past year attempts have been made to cross *C. arabica* and *C. Dybowskii* and also this latter species and *C. eugenioides*. The former cross gives some hopes of success, the young fruits are already swelling but not as quickly as those of selfed *C. arabica*. There are no obvious signs of success in the second cross. The fruits on the *C. eugenioides,* although still green, show no signs of development.

26. Trees of the first generation of the cross *C. arabica* x *C. canephora* have set a fair quantity of fruit (open pollinated) during this season and so far 82 plants have been raised. The survivors of the second generation from this cross, planted in the field in December, 1936, have for the most part made good growth. Attempts to pollinate the flowers of the first generation hybrids with pollen of the Robusta parent were not successful, all the fruits formed having ill-developed seeds which failed to germinate.

27. Cytological studies of *Coffea* species have been continued and the study of the behaviour of the interspecific hybrid *C. arabica* x *C. canephora* in meiosis is practically complete.

28. Specimens and seed of a coffee found growing wild at Embu were sent to me by the Agricultural Officer and Experimentalist from the Scott Laboratories. This plant, resembling *C. arabica* in many respects, is a diploid Coffea ($2n=22$) and its development is being watched with great interest.

Aleurites.

29. The young plantations of *Aleurites montana* planted in 1933 and 1934 have flowered during the year and observations were made on the sex of the trees and the proportions of the sexes. Seventy-six of the 124 plants examined were in flower and the sexes were in the proportions 60·5 per cent. purely female 23·7 per cent. purely male and 15·8 per cent. monoecious, but with a preponderance of male flowers.

30. Casual observations, on some of the older trees on the station, indicate that there may be a change in the sex proportions and also a change in the dominant sex of a tree, so that the continuation of these observations through a series of years should furnish interesting information. There will shortly be plenty of other material available for this study as a few plants in the young plantation at Kwamkoro have flowered this year.

L. R. DOUGHTY,
Geneticist.

SYSTEMATIC BOTANY.

In July I was granted permission to visit the island of Mafia which lies about forty miles off the mouth of the Rufiji Delta. The main objects of my visit were to compare the vegetation and flora of this island with those of Zanzibar and Pemba, which had already been studied, and to determine their affinities with those of the East African mainland.

I was in Mafia from the end of July till the middle of October, when I went on leave. During this time I covered the area of the island, which is 200 square miles, and studied the different vegetation types and communities and collected four hundred plants in triplicate. I also made notes on the distribution of the different soil types and took a series of soil samples for the Soil Chemist, Amani. I also supervised the work of an African bird collector for the Secretary of Amani and was thus able to obtain for him practically the first authentic information on the birds of the island.

I wish to take this opportunity of thanking the Provincial Commissioner, Dar es Salaam, for help received from the Administration when in Mafia. My thanks are especially due to Mr. G. S. Brown of the Agricultural Department for his information and assistance when on the island, without which I should not have been able to accomplish so much in the time at my disposal.

During my leave I spent a few months in Paris and visited the Musée d'Historie Naturelle to study the Sacleux collections of East African coastal plants. Unfortunately an injury contracted in Mafia prevented me from visiting the Museum as often as I should have liked.

I am now working out the results of the Mafia Island survey at the Herbarium of the Royal Botanic Gardens, Kew, and the British Museum, by kind permission of the Directors of these institutions. I hope to be able to identify all the plants that were collected and complete an account of the island and its vegetation by the end of May when my leave terminates.

At Dar es Salaam, on my way to Mafia, I met Mr. Raymond, the Analytical Chemist, Medical Department, Tanganyika Territory, and discussed with him the subjects of native food and medicinal and poisonous plants. Through his kindness I was able to pay a week-end visit to Kiserawe in the Pugu Hills to collect and gain an idea of the vegetation of this region.

During the year my compilation *A Swahili Dictionary of Plant Names* was published by the Government Printer, Dar es Salaam.

P. J. GREENWAY,
Systematic Botanist.

ORNITHOLOGY.

1. Progress with the faunistic research financed by the British Museum has been good. Attention was devoted mainly to the mountains of East Central Tanganyika, the Ngurus, the Kiboriani block (Mpwapwa), and the Ulugurus, the first two of which were practically unknown zoologically. I visited this area for a few days in September, in the course of which I received much appreciated facilities from the Forest and Veterinary Departments. Kiboriani showed marked affinities with the mountains of South-West Tanganyika; the Ngurus have still not been sufficiently worked; the peculiar nature of the Uluguru fauna was further emphasized by the discovery of a bird allied to Eminia, but not clearly assignable to any known genus. It will be described shortly, after further study in the British and Berlin Museums.

2. A short visit by the collector to the top of the Teita Hills proved fruitful. The avifauna of the three small surviving patches of forest was known from American work to be vestigial, poor in species but relatively rich in endemics. Now another endemic has been found to be common there, a most distinct subspecies, which I have described as *Apalis murina fuscigularis* (Bull. B.O.C., 58, p. 48, 1937). It is a replica of the bird of Usambara and Pare except that, unlike all the others of this numerous group of Apalis forms, it has the throat black, instead of white. The intrinsic interest of *A. m. fuscigularis* is much increased by the fact that another of the Teita endemics, the Thrush, *Turdus olivacepus helleri,* is also a striking melanic modification of the Usambara—Pare bird (*T. o. roehli*), while the Kilimanjaro representatives of both the Apalis and the Thrush are quite different.

3. The aim of all this faunistic work is to examine distribution and differentiation with regard to degree of isolation. Since the localities are continental, the isolation must be assessed in terms of vegetation and climate, not merely by distance. At present, climatic maps of East Africa, the essential basis for one side of the discussion I have in mind, do not exist. For their construction we need not only routine data, which the British East African Meteorological Service is actively accumulating, but also a satisfactory system of climatic classification. In the last 50 years many different systems have been evolved, but none with special reference to the peculiar conditions of a mountainous country within a few degrees of the Equator.

Since no comprehensive review of the various systems is available, I have found it necessary to examine them in some detail. The bibliographical assistance given me by the British Meteorological Office and by the Imperial Bureau of Soil Science has gone far towards off-setting the disabilities attendant on such research in East Africa; so that I have been able to prepare a

review that, while closely concerned with local conditions, is general and in some respects fairly comprehensive. A number of scientific critics, interested in various aspects of the study, have been good enough to examine my draft; and it is proposed, to offer the review for publication under the title " Climatic classification from an East African standpoint ".

4. A notable gap in the biology of East Africa has been caused by the neglect of Mafia Island. Although it is comparable in size and in potential interest with Pemba and Zanzibar, no birds at all have been recorded from Mafia except for a couple of dozen collected towards the end of last century, mainly by Voeltzkow. Thanks to Mr. Greenway, who took a bird collector with him on his recent botanical survey, a good deal is now known about the Mafia avifauna. When the collection has been worked out and, I hope, supplemented, a comparison of the list with those of Pamba, Zanzibar and the neighbouring coast-lands will be undertaken, with particular reference to the environments.

5. The accident of having two young *Turacus fischeri* brought in, which Mrs. Moreau reared by hand, has enabled me to make some detailed observations on this species. The Order to which they belong, the Musophagiformes, is the only one confined to the African Region, and it is one that has been shown by Phillips (*S. Afr. J. Sci.*, 1928) to be an important factor in forest regeneration. In seeking to relate my observations to published information on related species, I have realized that the biology of the Order presents a number of remarkable features, which are most imperfectly documented. Thanks especially to the generous collaboration of Mr. G. L. Bates in London, of Dr. V. G. L. van Someren and of Lieut.-Colonel H. F. Stoneham, I have been able to collate a good deal of scattered information, both published and unpublished, on the Turacos in general, under the title " A contribution to the biology of the Musophagiformes ".

6. As opportunity occurred, data have been accumulated on the various lines of work mentioned in earlier reports. In particular, week-end observations have been maintained on that great and economically important group, the weaver-birds. Among the *Ploceus* spp. (*sensu lato*) it becomes evident that breeding biology varies strikingly, some being monogamous and some polygamous, with associated differences in the share of the sexes in the various operations of the breeding cycle. Whether these biological differences follow sub-generic lines can only be tested by study of a larger number of species.

The breeding of Bishop Birds (*Euplectes*) of two closely allied species, *E. hordeacea* and *E. nigroventris*, has now been observed in the same spots for several years. The results to date show a highly specific difference in " territorialism " and in

phenology. *E. hordeacea* appears to have a specific size of territory, with relatively narrow vegetational preferences; *E. nigroventris* appears to be almost indefinitely "compressible," the size and success of the territory having no connection with its intrinsic advantages or disadvantages. The facts have been summarized in "The comparative breeding biology of two *Euplectes* spp. in Usambara," at present with the Editor, *Journal of Animal Ecology*.

7. During the nine months under report the under-mentioned publications have appeared.

Comparative breeding biology of the African Hornbills. Proc. Zool. Soc. London, Ser. A, 1937, pp. 331-346.

Migrant birds in Tanganyika Territory. Tanganyika Notes Rec., No. 4, pp. 1-34, 1937.

The avifauna of the mountains along the Rift Valley in North Central Tanganyika. Part I. Ibis, Ser. 14, vol. 1, pp. 760-786, 1937.

In addition, *Bird migration over the north-west part of the Indian Ocean, the Red Sea and the Mediterranean* is in the press (Proc. Zool. Soc. London).

As in preceding years, I am indebted to Mrs. Moreau for most valuable collaboration.

R. E. MOREAU.

PLANTATION WORK.

The development of the Kwamkoro Estate again occupied a large part of the time of the Superintendent, and his tour of service was extended until January in order to complete the establishment of the principal crops under the present scheme. Good progress has been made and completion of the new plantings is in sight.

Demands by the scientific officers of the station for planting material, and the collection and raising of plants and cuttings for distribution, have also increased considerably.

Amani Plantations and Nurseries.

Aleurites montana.—All plantings of this species at Amani continue to do well. Two of the original trees in the nursery again fruited heavily and produced 54½ lb. of fresh seeds per tree. A few trees in the plantations also fruited. In addition to seeds sown at Amani for refills at Kwamkoro, 55 lb. of seeds were supplied to the Tanganyika Agricultural Department, 25 lb. to Kenya Agricultural Department and 15 lb. to local planters in the Northern Province of Tanganyika. At the time of writing the trees in the nursery and several in the plantations are again fruiting well.

Aleurites Fordii.—The plants of this species, although fruiting again, still make no appreciable growth. Only 1 lb. of seed was distributed during the year; a further 2 or 3 lb. will probably be available for distribution.

Derris elliptica.—(Tuba Root). Much work has been done on this crop during the year for the Biochemist. In addition to the material supplied to him from Kwamkoro, 1,200 plants have been raised and planted out at Amani. Plants are also being raised for a further experiment to be planted out in the coming year.

The varieties of *Derris elliptica* from Singapore, Seychelles and Ceylon, together with *Derris malaccensis* and *Derris polystachys* in the Amani collection continue to do well. The experiment has been tried of grafting the Amani variety of *D. elliptica,* which has been shown to be very toxic, on to *Derris malaccensis* stocks. Side grafting failed but three inarched plants have grown and have been planted in the nursery. A few more plants are being inarched on the same stock.

Mundulea suberosa.—The mundulea plots in the Sigi area continue to grow well.

Tephrosia spp.—A plot is being prepared for planting the different species of Tephrosia required for investigation by the biochemist.

Cinchona.—30,000 plants have been raised in the Amani nurseries from seed purchased from India. This seed, collected from selected trees, germinated well. Of the 30,000 raised, 24,000 have been transferred to Kwamkoro, and the remainder retained for planting at Amani. The old-established Cinchona trees have flowered well this year and all outstanding orders for seeds, unavoidably held over from last year, have been supplied.

Coffee.—Plants of the various Caffea species and varieties have been raised only to meet the demands of the scientific staff.

Boehmeria nivea.—There is still a small demand for planting material of Ramie. During the year 13 cwt. of root divisions were distributed. The plot has been replanted.

Agave spp.—Work on agaves occupied a large part of the time of the nursery staff during the year.

Nine hundred and seventy-two plants were raised and sent to the Sisal Experimental Station, chiefly in connection with the Geneticist's breeding work. Eight thousand suckers and 200,000 bulbils of blue sisal were distributed. Seeds of *Agave* spp. were introduced from La Mortala, while we are also again indebted to Colonel the Hon. M. T. Boscawen for a number of plants imported through quarantine from Mexico and South-West Africa. In all some 50 Agave species and varieties were added to the Amani collection, bringing the total number introduced to 119, most of which are still represented.

Dioscorea spp.—The collection of yams mentioned in the last annual report have grown well. Sets of 26 varieties were distributed to the Tanganyika Agricultural Department, 19 to the Kenya Department, and 19 to the Uganda Department. Sets of each variety have been replanted for further distribution if required.

Quarantine.

Thirty-four sugar cane varieties, five collections of succulents, seventeen varieties of cassava, a collection of orchids and a collection of miscellaneous plants were received into quarantine during the year. The following is a list of the sugar-cane varieties.

P.O.J., 2803 (did not survive).	B, 3337.
C.P., 807.	B, 34105.
Mayaguez, 49.	B, 34106.
CO, 404.	B, 34110.
CO, 407.	B, 34120.
CO, 411.	B, 34123.
CO, 417.	B, 34129.
P.O.J., 2875.	B, 34130 (did not survive).
CO, 360.	B, 34134.
CO, 408.	B, 34137.
CO, 421.	B, 35151.
D., 625.	B, 35176.
P.O.J., 2803 (2nd importation).	B, 35179.
Mayaguez, 61.	B, 35187.
Mayaguez, 63.	B, 35221.
Mayaguez, 151.	B, 35237.
B, 3215.	B, 35245.

Kwamkoro Estate.

Details of work done and the condition of the different crops are as follows:—

Tung Oil (*Aleurites montana*).—The area of more than 100 acres continues to do well. Excellent growth has been made, especially by the two year old plants. A few trees have flowered. All casualties have been replaced. Rutine ring weeding, digging and mulching have been carried out. As there are a large number of unproductive male trees in the older plantations it is intended that where male trees occur, two seedlings should be planted. The excess plants would be removed later, leaving only an adequate number of males, well distributed through the plantation. It is thus hoped to limit the number of male trees to approximately 10 per cent.

Grafting experiments and raising plants from root cuttings of selected trees also to be carried out.

Tuba Root (*Derris elliptica*).—The whole of the Derris plantings are growing well. From the 1935 and 1936 plantings, no less than 30,000 plants (grown in bamboo pots) and over 80,000 cuttings have been obtained. Of the plants 20,000 went into the Kwamkoro estate, 1,000 to Amani for the Biochemist's investigations and the remaining 9,000, together with some 70,000 cuttings, to planters and Agricultural Departments in East Africa. Ten thousand cuttings are also being rooted in the Amani nursery for the 1938-9 planting at Kwamkoro.

In 1935 and 1936 plantings were made 4ft. by 4ft. Experience has now shown that by planting at this distance the cost of digging the root is out of proportion to the amount of root obtained. The 1937 planting has been in beds 8 ft. wide, five rows to each bed and 2 ft. between the plants. A space of 6 ft. is allowed between the beds to allow sufficient space for the foliage to develop. Although this method may slightly reduce the amount of root to be obtained per plant, it should more than compensate this loss by the saving in cost of harvesting. Experiments are also being made on different beds with applications of farmyard manure, compost, superphosphate and lime.

Cinchona.—Considerable progress has been made during the year. One plantation, 76·4 acres, has been completed. The total number of plants in this area is *C. ledgeriana* 42,048, *C. succirubra* 15,926 and hybrids 22,388. Ten thousand hybrid plants left over in the nursery have been interplanted in the old Arabica coffee plantation adjoining the nursery. Fifteen thousand hybrids and 35,000 *C. ledgeriana* plants are now ready in the nursery for planting in another old Arabica area. Twenty-four thousand *C. ledgeriana* plants have been raised from seed of selected trees obtained from India. The planting of these will complete the establishment of the area under the present programme. *C. ledgeriana* planted in the early part of 1936 continues to do well.

Coffea robusta.—Approximately 100 acres has been planted and maintained by cleaning with bushknives, ring weeding and digging. It has been realized for some time that if the cultivation of *Coffea robusta* is to be successful no competition for nutrients by other vegetation must be allowed. Work on the 10-acre plot to be grown under an intensive culture system is well advanced. Both open and covered cattle sheds have been built on sites adjoining the plot and sufficient manure accumulated for the preparation of the holes for planting.

Coffea arabica (grafted).—The planting of a 10-acre plot with *C. arabica* on *C. robusta* stocks is completed. This also is being grown on an intensive culture system. Before planting the plot

was manured at the rate of 15 tons per acre. A second application has now begun. The plants although slow at first, are now making satisfactory growth.

Ginger.—A small plot of ginger was grown in the old *Coffea robusta* nursery. Two hundred pounds of rhizomes were supplied to the Tanganyika Agricultural Department. A small plot has again been planted.

General.—With the exception of clearing for other crops, no work was done on the old *Coffea arabica* plantations during the year, the areas being used for grazing the animals.

One and a half tons of first grade *Coffea arabica* and one ton (clean) of *Coffea robusta* were harvested during the nine months.

Rainfall for the calendar year 1937 was 93·24 inches.

VISITORS.

In connection with the meeting of the East African Coffee Producers on 5th August, 1937, the following visited Amani:—

Mr. L. B. Freeston, Secretary, Governors' Conference; Major C. M. Taylor, Messrs. G. J. L. Burton, R. E. Norton and G. P. Saben (Kenya); Messrs. E. Harrison and S. M. Gilbert (Tanganyika); Messrs. A. S. Richardson, C. E. J. Biggs, D. N. Stafford and H. A. Cannon (Uganda).

Other East African visitors include:—

Major W. E. H. Scupham, Secretariat, Dar-es-Salaam; Mr. G. W. Nye, Department of Agriculture, Uganda; Mr. D. K. S. Grant, Conservator of Forests, Tanganyika; Mr. H. E. Hornby, Director of Veterinary Services, Tanganyika; G. E. Frhr. von Stietencron; Mr. L. A. Markham, Forestry Department, Tanganyika; Mr. C. A. Thorold, Department of Agriculture, Kenya; Mr. F. A. F. Schmid; Mr. N. V. Rounce, Department of Agriculture, Tanganyika; Mr. G. E. Tidbury, Department of Agriculture, Zanzibar; Mr. H. B. Stent, Coffee Research Station, Lyamungu; Mr. C. Gillman, Chief Engineer, Tanganyika Railways; Mr. D. L. Blunt, Director of Agriculture, Nyasaland; Dr. G. Maclean, Acting Director of Medical Services, Tanganyika.

Mr. E. Burtt, temporarily employed on special investigations into transmission of trypanosomiasis by tsetse, spent six months at Sigi, near Amani, during which time he received assistance from the staff.

Overseas visitors include:—

Mr. A. de Bauw, Brussels; Messrs. Hacquart and Brynaert, Belgian Congo; Mr. R. H. Goodwin, Boston, Mass.; Dr. Richard Hindorf, Berlin; and Dr. Walter Carter of Honolulu, who made an extended stay in connection with his work on the mealybugs of pineapple.

APPENDIX A.

Financial statement for the year ended 31st December, 1937.

Revenue.

	£
H.M. (Imperial) Treasury	6,000
Contribution Tanganyika Territory	6,253*
Contribution Uganda	1,876*
Contribution Kenya	1,771*
Contribution Zanzibar	1,200
Contribution Northern Rhodesia	300
Contribution Nyasaland	300
	17,700
Local sales	598
Total	£18,298

Maintenance Expenditure.

	£
Personal Emoluments	10,380
Passages	898
Pensions Contributions	1,748
Laboratories	847
Library	15†
Publications	88
Office, Telephones and Contingencies	218
Materials	554
Freight and Transport	295
Travelling	643
Labour	1,384
	£17,070

	£
Saving on the year's maintenance (due to belated arrival of Director)	1,228

Capital Expenditure.

	£
Reconditioning quarters	31
Two lorries	281
Electrical reconstruction	59
	£371

* The increase over the contributions of the preceding years is on account of the appointment of the second physiologist (part-year).

† The maintenance of the Library was borne almost entirely by the Carnegie Trust Fund.

Summary.	£	£
Recurrent Revenue	18,298	
Reserve on 31st December, 1936	2,156	
Transfer from Kwamkoro Reserve	457	
		20,911
Maintenance Expenditure	17,070	
Capital Expenditure	371	
		17,441
Reserve on 31st December, 1937		3,470
Capital expenditure authorised out of Reserve		1,325
Balance		£2,145

APPENDIX B.

List of publications distributed up to 31st December, 1937, by the East African Agricultural Research Station.

Memoirs.

1. Records of butterfly migration in East Africa. C. B. Williams, *East Afr. Uganda Nat. Hist. Soc.*, No. 35, pp. 1-16, 1929.
2. Collected records relating to insect migration, First and Second Series. C. B. Williams, *Trans. Ent. Soc.*, London, Vol. 77, pp. 79-91, 1928; Vol. 79, pp. 139-170, 1930.
3. Locust-hoppers and birds in East Africa. R. E. Moreau, *Bull. Ent. Res.*, Vol. 21, Part 2, pp. 141-145, 1930.
4. The bird-population of a settled valley in the West Usambaras, Tanganyika Territory. R. E. Moreau, *J. Ecol.*, Vol. 19, No. 1, pp. 64-74, 1931.
5. The filtration of the virus of streak disease of maize. H. H. Storey, *Ann. Appl. Biol.*, Vol. 19, No. 1, pp. 1-5, 1932.
6. The estimation of carbon in plant tissues, R. R. Worsley and F. J. Nutman, *Ann. Bot.*, Vol. 45, pp. 693-707, 1931.
7. A bark disease of coffee in East Africa. H. H. Storey, *Ann. Appl. Biol.*, Vol. 19, No. 2, pp. 173-184, 1932.
8. Vegetation of Mpwapwa, Tanganyika Territory. P. J. Greenway, *J. Ecol.*, Vol. 21, No. 1, pp. 28-43, 1933.
9. Pleistocene climatic changes and the distribution of life in East Africa. R. E. Moreau, *J. Ecol.*, Vol. 21, No. 2, pp. 415-435, 1933.
10. On the food of the Red-billed Oxpecker. R. E. Moreau, *Bull. Ent. Res.*, Vol. 24, Part 3, pp. 325-335, 1933.
11. The inheritance by an insect vector of the ability to transmit a plant virus. H. H. Storey, *Proc. Roy. Soc. B.*, Vol. 112, pp. 45-60, 1932.
12. A sulphur-deficiency disease of the tea bush. H. H. Storey and R. Leach, *Ann. Appl. Biol.*, Vol. 20, Part 1, pp. 23-56, 1933.
13. A note on the distribution of *Gypohierax angolensis* (Gmel.), the Vulturine Fish-eagle. R. E. Moreau, *J. Animal Ecol.*, Vol. 2, No. 2, pp. 179-183, 1933.
14. Observations on the Desert Locust in East Africa from July, 1928, to April, 1929. C. B. Williams, *Ann. Appl. Biol.*, Vol. 20, No. 3, pp. 463-497, 1933.
15. A contribution to tropical African bird-ecology. R. E. Moreau, *J. Animal Ecol.*, Vol. 3, No. 1, pp. 41-69, 1934.
16. A chemical survey of the waters of Mount Meru, Tanganyika Territory, especially with regard to their qualities for irrigation. D. Sturdy, W. E. Calton and G. Milne. *J. East Afr. Uganda Nat. Hist. Soc.*, No. 45, pp. 1-38, 1933.
17. Investigations of the mechanism of the transmission of plant viruses. H. H. Storey, *Proc. Roy. Soc. B.*, Vol. 113, pp. 463-485, 1933.

18. Root-systems of *Coffea arabica*, Parts I and II. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. I, pp. 271-284, 285-296, 1933.
19. Taxonomic and field notes on some birds of North-East Tanganyika Territory. W. L. Sclater and R. E. Moreau, *Ibis* (Ser. 13, Vol. 2), pp. 487-522, 656-683, 1932 (Ser. 13, Vol. 3), pp. 1-33, 187-219, 399-440, 1933.
20. Some East African essential oils. R. R. Worsley, *Bull. Imp. Inst.*, Vol. 32, pp. 253-270, 1934.
21. The insecticidal properties of some East African plants. R. R. Worsley, *Ann. App. Biol.*, Vol. 21, pp. 649-669, 1934.
22. Root-systems of *Coffea arabica*, Part III. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. 2, pp. 293-392, 1934.
23. The photodynamic action of methylene blue on the virus of a plant disease. H. H. Storey, *Ann. Appl. Biol.*, Vol. 21, pp. 588-589, 1934.
24. Some eco-climatic data for closed evergreen forest in tropical Africa. R. E. Moreau, *J. Linn. Soc. Zool.*, Vol. 39, pp. 285-293, 1935.
25. A synecological study of the Usambara Mountains, Tanganyika Territory, with particular reference to birds. R. E. Moreau, *J. Ecol.*, Vol. 23, pp. 1-43, 1935.
26. Cinchona in Amani. R. R. Worsley, *Bull. Imp. Inst.*, Vol. 33, pp. 14-31, 1935.
27. Some suggested units of classification and mapping, particularly for East African soils. G. Milne, *Soil Research*, Vol. 4, pp. 183-198, 1935.
28. Studies on the ecology of coffee plantations in East Africa, I: The climate and eco-climates of coffee plantations. T. W. Kirkpatrick. Published by the Crown Agents for the Colonies, London, 1935.
29. A short geographical account of the soils of East Africa. G. Milne, in collaboration with East African soil chemists. *Trans. 3rd Internat. Cong. Soil Sci.*, Vol. I, pp. 270-274, 1935.
30. Composite units for the mapping of complex soil associations. G. Milne, *Ibid.*, pp. 345-347, 1935.
31. A provisional soil map of East Africa. G. Milne, in collaboration with East African soil chemists. *Ibid.*, pp. 266-270, 1935.
32. A critical analysis of the distribution of birds in a tropical African area. R. E. Moreau, *J. Animal Ecol.*, Vol. 4, pp. 167-191, 1935.
33. A contribution to the ornithology of Kilimanjaro and Mt. Meru. R. E. Moreau, *P.Z.S. London*, 1935, pp. 843-891.
34. The insecticidal properties of some East African plants: 2 *Mundulea suberosa* Bentham, Pt. I. Insecticidal properties. R. R. Worsley, *Ann. Appl. Biol.*, Vol. 23, No. 2, pp. 311-328, 1936.
35. Mundulea fish poison. P. J. Greenway, *Kew Bull.*, No. 4, pp. 1-8, 1936.
36. A provisional soil map of East Africa (Kenya, Uganda, Tanganyika and Zanzibar) with explanatory memoir. G. Milne in collaboration with East African Soil Chemists. Published by the Crown Agents for the Colonies, London, 1936.
37. Breeding seasons of birds in East African evergreen forests. R. E. Moreau. *P.Z.S. London*, 1936.
38. Chromosome behaviour in relation to genetics of Agave: I. Seven species of fibre Agave. L. R. Doughty, *J. Genet.*, Vol. 33, No. 2, pp. 197-205, 1936.
39. Rotenone I: The determination of rotenone. R. R. Worsley, *J. Soc. Chem. Ind.*, Vol. 55, pp. 349T-357T, 1936.
40. The breeding biology of certain East African hornbills. R. E. Moreau, *J. East Afr. Uganda Nat. Hist. Soc.*, Vol. 13, pp. 1-28, 1936.
41. Rotenone II: Evaluation of plants containing rotenone. R. R. Worsley, *J. Soc. Chem. Ind.*, Vol. 6, pp. 15-23T, 1937.
42. An inexpensive recording manometer. F. J. Nutman, *Ann. Bot.* N.S.I. (I), pp. 205-6, 1937.

43. Agave fibres. Pts. I and II. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. 5, pp. 75-92, 93-111, 1937
44. Colour vision in the triungulin larva of a Strepsipteron (*Corioxenos antestiae* Blair). T. W. Kirkpatrick, *Proc. R. Ent. Soc.* London, Vol. 12 (A), pp. 40-44, 1937.
45. A new virus disease of maize transmitted by *Cicadulina* spp. H. H. Storey, *Ann. Appl. Biol.*, Vol. 24, pp. 87-94, 1937.
46. Note on soil conditions and two East African vegetation types. G. Milne, *J. Ecol.*, Vol. 25, pp. 254-258, 1937.
47. The evaluation of derris and mundulea. R. R. Worsley, *J. Soc. Chem. Ind.*, Vol. 57, pp. 175-176T, 1937.
48. Insecticidal properties of some East African plants: III. *Mundulea suberosa* Benth. Part 2. Chemical constituents. Part 3. Variability of samples. R. R. Worsley, *Ann. Appl. Biol.*, Vol. 24, pp. 651-664, 1937.
49. Essays in applied pedology. I. Soil type and soil management in relation to plantation agriculture in East Usambara. G. Milne, *East Afr. Agr. J.*, Vol. 3, pp. 1-14, 1937.
50. Studies of the physiology of *Coffea arabica:* I. Photosynthesis of coffee leaves under natural conditions. F. J. Nutman, *Ann. Bot.* (N.S.), Vol. 1, pp. 353-368,1937.
51. Migrant birds in Tanganyika Territory. R. E. Moreau, *Tanganyika Notes Rec.*, No. 4, pp. 1-34, 1937.

Reprints.

1 and 2. Biological and other notes on some East African birds. R. E. and W. M. Moreau. Parts I and II. *Ibis*, Ser. 14, Vol. 1, pp. 152-174, 321-343, 1937.
3. Normal erosion as a factor in soil profile development. G. Milne. *Nature*, Vol. 136, p. 548, 1936.
4. A Swahili dictionary of plant names. P. J. Greenway. Government Printer, Dar es Salaam, 1937.

Publications not available for distribution on 31st December, 1937.

Biochemical studies of *Derris* and *Mundulea*. I. The histology of rotenone in *Derris elliptica*. R. R. Worsley and F. J. Nutman. *Ann. App. Biol.*, Vol. 24, pp. 696-702, 1937.

Defaecation of Jassid species. H. H. Storey and R. F. W. Nichols, *Proc. R. Ent. Soc. London*, Vol. 12 (A), pp. 149-150. 1937.

Studies of the Physiology of *Coffea arabica*. II. Stomatal movements in relation to photosynthesis under natural conditions. F. J. Nutman. *Ann. Bot.* (N.S.) Vol. 1, pp. 681-693, 1937.

The avifauna of the mountains along the Rift Valley in north central Tanganyika (Mbulu District). R. E. Moreau. Parts I and II. *Ibis*, ser. 14, vol. 1, pp. 760-786, vol. 2, pp. 1-32, 1938.

Studies in the ecology of coffee plantations in East Africa. II. The autecology of *Antestia* spp. (Pentatomidae) with a particular account of a Strepsipterous parasite T. W. Kirkpatrick. *Trans. R. Ent. Soc.*, Vol. 86, pp. 247-343, 1937.

Experimental breeding of fibre agaves in East Africa. L. R. Doughty. *East Afr. Agr. J.*, vol. 3, pp. 222-228 (1937), pp. 268-278 (1938).

The internal anatomy of *Corioxenos antestiae* (Strepsiptera). B. Cooper. *Trans. R. Ent. Soc. London*, in press.

Bird migration over the north-western part of the Indian Ocean, the Red Sea and the Mediterranean. R. E. Moreau. *Proc. Zool. Soc. London*, in press.

Comparative breeding ecology of two *Euplectes* spp. in Usambara. R. E. and W. M. Moreau. *J. Anim. Ecol.*, in press.

Essays in Applied Pedology. II. Some factors in soil mechanics. G. Milne. *East Afr. Agr. J.*, in press.

(11354—47) Wt. P1156—4072 1125 8/38 P. St. G. 377/7

Reports, etc., of Imperial and Colonial Interest

THE INTRODUCTION OF PLANTS INTO THE COLONIAL DEPENDENCIES OF THE BRITISH EMPIRE

A Summary of Legislation as at the end of December, 1936
[Colonial No. 141] 1s. (1s. 1d.)

EDUCATION IN THE WEST INDIES

Report of Commission appointed to consider Problems of Secondary and Primary Education in Trinidad, Barbados, the Leeward Islands and the Windward Islands
[Colonial No. 79] 2s. (2s. 2d.)

THE FINANCIAL POSITION AND SYSTEM OF TAXATION OF KENYA

Report of the Commission appointed to enquire into and report on
[Colonial No. 116] 9s. (9s. 6d.)

THE FINANCIAL AND ECONOMIC POSITION OF NORTHERN RHODESIA

Report of the Commission appointed to enquire into and report on
[Colonial No. 145] 7s. (7s. 6d.)

NUTRITION POLICY IN THE COLONIAL EMPIRE

Despatch from the Secretary of State for the Colonies dated 18th April, 1936
[Colonial No. 121] 2d. (2½d.)

MUI TSAI IN HONG KONG AND MALAYA

Report of Commission [Colonial No. 125] 5s. (5s. 4d.)

PENSIONS TO WIDOWS AND ORPHANS OF OFFICERS IN THE COLONIAL SERVICE, AND COLONIAL PROVIDENT FUNDS

Report of Committee [Cmd. 5219] 1s. (1s. 1d.)

LEAVE AND PASSAGE CONDITIONS IN THE COLONIAL SERVICE

Report of Committee [Cmd. 4730] 9d. (10d.)

Lists are issued showing schedules of Offices in the following Colonial Services with the names and brief biographical records of the holders. Each list includes the Special Regulations by the Secretary of State relating to the Service concerned :—

Colonial Administrative Service List	[Colonial No. 137] 2s. 6d. (2s. 8d.)
Colonial Agricultural Service List	[Colonial No. 143] 1s. 3d. (1s. 5d.)
Colonial Forest Service List	[Colonial No. 122] 6d. (7d.)
Colonial Legal Service List	[Colonial No. 138] 9d. (10d.)
Colonial Medical Service List	[Colonial No. 140] 1s. 3d. (1s. 5d.)
Colonial Veterinary Service List	[Colonial No. 132] 6d. (7d.)

All prices are net. Those in brackets include postage

Obtainable from

HIS MAJESTY'S STATIONERY OFFICE

LONDON, W.C.2 : York House, Kingsway
EDINBURGH 2 : 120, George Street MANCHESTER 1 : 26, York Street
CARDIFF : 1, St. Andrew's Crescent BELFAST : 80, Chichester Street
or through any bookseller

COLONIAL ANNUAL REPORTS

H.M. Stationery Office publishes the Annual Reports on the Social and Economic Progress of the Peoples of the Colonies and Protectorates, most of which contain a map of the Dependency concerned. More than 40 Reports appear each year and they are supplied at the Subscription price of 50s. per annum. (This rate does not include Mandated Territories.) Individual Reports may also be purchased and standing orders placed for their annual supply

BAHAMAS
BARBADOS
BERMUDA
BRITISH GUIANA
BRITISH HONDURAS
BRITISH SOLOMON ISLANDS PROTECTORATE
BRUNEI, STATE OF
CAYMAN ISLANDS (JAMAICA)
CEYLON
CYPRUS
FALKLAND ISLANDS
FEDERATED MALAY STATES
FIJI
THE GAMBIA
GIBRALTAR
GILBERT & ELLICE ISLANDS
GOLD COAST
GRENADA
HONG KONG
JAMAICA
JOHORE
KEDAH
KELANTAN
KENYA COLONY & PROTECTORATE
LEEWARD ISLANDS
MAURITIUS
NEW HEBRIDES
NIGERIA
NORTHERN RHODESIA
NYASALAND
PERLIS
ST. HELENA
ST. LUCIA
ST. VINCENT
SEYCHELLES
SIERRA LEONE
SOMALILAND
STRAITS SETTLEMENTS
TONGAN ISLANDS PROTECTORATE
TRENGGANU
TRINIDAD & TOBAGO
TURKS & CAICOS ISLANDS
UGANDA
ZANZIBAR PROTECTORATE

BASUTOLAND
BECHUANALAND PROTECTORATE
SWAZILAND

MANDATED TERRITORIES

Annual Reports are published on the undermentioned territories administered by H.M. Government under mandate from the League of Nations

PALESTINE AND TRANS-JORDAN
TANGANYIKA TERRITORY
CAMEROONS under British Mandate
TOGOLAND under British Mandate

Further particulars as to the latest reports and prices are obtainable from the Sale Offices of

HIS MAJESTY'S STATIONERY OFFICE

CROWN AGENTS FOR THE COLONIES

Publications issued by the Governments of British Colonies, Protectorates, and Mandated Territories can be obtained from the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1. They include Departmental Reports, Laws, Handbooks, etc.

S.O. Code No. 88-303-51-37